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(71) Applicant (for IS only): HARDING, Richard, Patrick [GB/GB]; Marks & Clerk, 4220 Nash Court, Oxford Business Park South, Oxford, Oxfordshire OX4 2RU (GB).

(21) International Application Number: PCT/GB01/02791

(72) Inventor; and

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(75) Inventor/Applicant (for US only): BAILEY, Thomas [US/US]; 13055 Pebblebrook, Houston, TX 77079 (US).

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(74) Agent: HARDING, Richard, Patrick; Marks & Clerk, 4220 Nash Court, Oxford Business Park South, Oxford, Oxfordshire OX4 2RU (GB).

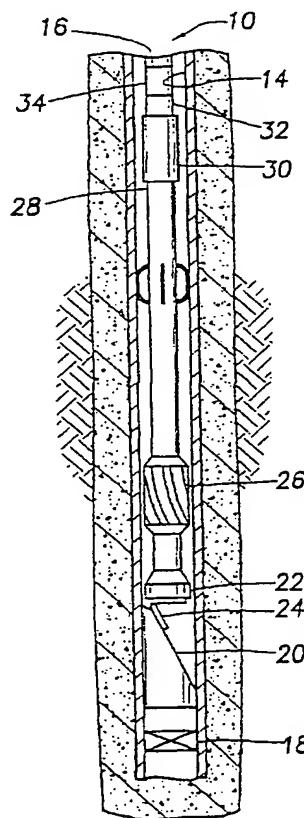
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[Continued on next page]

(54) Title: MILLING OF CASING USING COILED TUBING



(57) Abstract: The present invention provides a system and method for setting an anchor (18) and/or whipstock (20) attached to a downhole motor (28) having a cutting tool (22) attached to a tubular member, such as coiled tubing (16). In one aspect, the motor allows flow therethrough sufficient to actuate an upstream MWD or other position measuring tool (32), and an orienter (34) if so equipped, and retain the orientation of the motor with the attached whipstock. An increased flow rate or pressure actuates the motor once the whipstock is set and rotation of the cutting tool or other equipment can begin.

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MILLING OF CASING USING COILED TUBING

The present invention relates to oil field tools. More specifically, the invention relates to an apparatus for and a method of using a motor in a tubular member disposed in a 5 wellbore.

Historically, oil field wells are drilled as a vertical shaft to a subterranean producing zone forming a wellbore, the wellbore is lined with a steel tubular casing, and the casing is perforated to allow production fluid to flow into the casing and up to the surface of 10 the well. In recent years, oil field technology has increasingly used sidetracking or directional drilling to further exploit the resources of productive regions. In sidetracking, an exit, such as a slot or window, is cut in a steel cased wellbore typically using a mill, where drilling is continued through the exit at angles to the vertical wellbore. In directional drilling, a wellbore is cut in strata at an angle to the vertical 15 shaft typically using a drill bit. The mill and the drill bit are rotary cutting tools having cutting blades or surfaces typically disposed about the tool periphery and in some models on the tool end.

Generally, components including an anchor, a whipstock coupled to the anchor and a 20 rotary cutting tool that progresses downward along the whipstock are used to cut the angled exit through the casing in the wellbore. The whipstock is an elongated cylindrical wedge-shaped member having an inclined concave deflection surface and guides the angle of the rotary cutting tool progressively outward to cut the exit. One or more of the components are attached to a tubing member, such as drill pipe or coiled 25 tubing, that is used to lower the components into the wellbore. The anchor typically is a bridge plug, packer or another supporting or sealing member. The anchor is set in a downhole position and extends across the wellbore to form an abutting surface for placement of subsequent equipment. The anchor can be secured in the wellbore by mechanical or hydraulic actuation of a set of jaws directed outward toward the casing or 30 wellbore. Hydraulic actuation generally requires a fluid source from the surface that pressurises a cavity in the anchor to actuate the jaws.

In the past, three "trips" have been used to cut the exit in the casing, using an anchor, a whipstock and a cutting tool. A trip generally includes lowering a tubular member with a cutting tool or other component into the wellbore, performing the intended operation, and then retrieving the members to the surface. The first trip sets the anchor in the 5 wellbore, the second trip sets the whipstock to the anchor and the third trip actuates the cutting tool to cut the exit along the whipstock. Such operations are time consuming and expensive.

Others in the field have realised the need to reduce the number of trips. An example of a 10 mechanically set anchor with reduced trips is described in U.S. Patent No. 3,908,759. A first trip mechanically sets a bridge plug having a latching member. In a second trip, the whipstock, attached to an end of a cutting mill, is engaged with the latching member, the connection to the mill is sheared, and the mill can begin cutting along the whipstock. The reference does not discuss how orientation is determined to properly set the 15 whipstock in position in the two trips.

An example of a hydraulic anchor, a whipstock and a cutting tool assembly that is set in a single trip is described in U.S. Pat. No. 5,154,231. The anchor and whipstock are set under hydraulic pressure and held by mechanical interlocks. Rotation of the cutting tool 20 shears the connection from the whipstock and the cutting tool can begin to cut the exit. However, the reference does not state how the angular orientation of the whipstock is achieved in the single trip.

Angular orientation of the whipstock in the wellbore is important to properly direct the 25 drilling or cutting. Most methods of orientation and initiation of cutting require multiple trips. Some systems allow orienting and setting of the whipstock in a single trip of a drill string in combination with a wireline survey instrument. For example, a known system includes an anchor, a whipstock and a cutter connected to a drill string. A wireline survey instrument is inserted through the drill string to determine proper orientation 30 prior to setting the whipstock. However, it is frequently necessary to circulate drilling fluid through the drill string at a low flow rate in order to push the wireline tool from the surface down to the region of the whipstock. The flow can prematurely set the anchor, unless some device such as a selectively actuated bypass valve is used to divert

the flow. Further, such methods require the separate use of the wireline survey instrument.

In contrast to the use of wireline survey instruments, the oil field industry is
5 increasingly using *in-situ* systems that are capable of collecting and transmitting data
from a position near the cutting tool while the cutting tool is operating. Such position
measuring tools are known as measuring-while-drilling (MWD) tools and are generally
situated at the lower end of the drill string above the cutting tool. The MWD tools
typically transmit signals up to surface transducers and associated equipment that
10 interpret the signals.

However, using an MWD tool in an assembly with a hydraulic anchor has challenges.
Typical MWD tools require drilling fluid flow rates even greater than the flow rate
required to push the wireline survey instrument downhole and increases the likelihood
15 of inadvertently setting the anchor. Thus, an increased flow rate bypass valve can be
used as described in U.S. Pat. No. 5,443,129. However, the system is suitable for a
typical drill string that is rotated by a conventional drilling apparatus on a surface
derrick. The disclosure does not address the current trends of using more flexible coiled
tubing requiring a downhole motor to rotate the cutting tool without substantially
20 rotating the coiled tubing.

Coiled tubing is increasingly being used to lower the costs of drilling and producing a
well. Coiled tubing is a continuous line of tubing typically wound on a reel on a mobile
surface unit that can be inserted downhole without having to assemble and disassemble
25 numerous threaded joints of a drill string. However, the coiled tubing is not sufficiently
rigid to accommodate rotational torque from the surface of the well along the tubing
length to rotate the cutting tool in contrast to systems using drill pipe. Thus, typically, a
downhole motor is mounted on the coiled tubing to rotate a cutting tool. Drilling fluid
flowed through the interior of the coiled tubing is used to actuate the motor to rotate the
30 cutting tool or other members.

A typical motor attached to the coil tubing is a progressive cavity motor. Figure 1 is a
schematic cross sectional view of a power section 1 of such a progressive cavity motor.

Figure 1A is a schematic cross sectional view of the downhole motor shown in Figure 1. Similar elements are similarly numbered and the figures will be described in conjunction with each other. The power section 1 includes an outer stator 2, an inner rotor 4 disposed within the stator. An elastomeric member 7 is formed between the 5 stator and rotor and is typically a part of the stator. The rotor 4 includes a plurality of lobes 6 formed in a helical pattern around the circumference of the rotor. The stator includes a plurality of receiving surfaces 8 formed in the elastomeric member for the lobes 6. The number of receiving surfaces is typically one more than the number of lobes. The lobes 6 are produced with matching lobe profiles and a similar helical pitch 10 compared to the receiving surfaces in the stator. Thus, the rotor can be matched to and inserted within the stator. Fluid flowing from the inlet 3 through the motor creates hydraulic pressure that causes the rotor 4 to rotate within the stator 2, as well as precess around the circumference of the receiving surfaces 8. Thus, a progressive cavity 9 is created that progresses from the inlet 3 to the outlet 5 as the rotor is rotated within the 15 stator 2. Fluid contained within the cavity is thereby exhausted through the outlet 5. The hydraulic pressure, causing the rotor to rotate, provides output torque for various tools attached to the motor.

It is desirable to orient an anchor and a whipstock with a cutting tool, a downhole 20 motor, an MWD tool and a downhole orienter coupled to coiled tubing, then set the anchor and whipstock and begin cutting an exit in a minimum number of trips. However, fluid flowed through coiled tubing to operate the MWD would also typically 25 actuate the motor. Thus, the rotating motor would be changing the orientation of the downhole anchor and whipstock indicated by the MWD, making orientation difficult at best.

There remains a need for a system and method for orienting and setting an anchor and/or whipstock using coiled tubing with a cutting tool and a downhole motor coupled thereto.

30 The present invention provides a system and method for orienting setting an anchor, a whipstock, a cutting tool and a downhole motor coupled to a tubular member, such as coiled tubing. In one aspect, the motor allows flow therethrough sufficient to actuate an

MWD or other position measuring tool, and an orienter if so equipped, and substantially retains the orientation of the motor with the coupled whipstock. An increased flow rate or pressure actuates the motor once the whipstock is set and rotation of the cutting tool or other equipment can begin.

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In one aspect, the invention provides a method of cutting a hole at an angle to a wellbore, comprising coupling a plurality of components including a position measuring tool, a downhole motor, a cutting tool, a whipstock and an anchor to a tubular member, orienting the whipstock to a desired orientation, and actuating the anchor. In another 10 aspect, the invention provides a system for cutting a hole at an angle to a wellbore, comprising a tubular member, and a plurality of components having a position measuring tool, a downhole motor, a cutting tool, a whipstock and an anchor coupled to the tubular member. In a further aspect, the invention provides an apparatus for use in a wellbore, comprising a motor body, a motor shaft disposed at least partially internal to 15 the motor body, and a fluid channel in communication with the motor shaft, the motor shaft being selectively non-rotational relative to the motor body while fluid flows through the motor at a first fluid flow rate and rotational while the fluid flows at a second fluid flow rate. In a further aspect, the invention provides a method of cutting a hole at an angle to a wellbore, comprising coupling an anchor to a coiled tubing, 20 actuating the anchor in the wellbore, coupling a position measuring tool, a downhole motor and a cutting tool to a coiled tubing, orienting the whipstock to a desired orientation, and actuating the motor to turn the cutting tool. In another aspect, the invention provides a system for cutting a hole at an angle to a wellbore, comprising a coiled tubing, an anchor coupled to the coiled tubing at a first time, and a position 25 measuring tool, a downhole motor, a cutting tool and a whipstock coupled to the coiled tubing at a second time.

Further aspects and preferred features are set out in the accompanying claims.

30 Some preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is a schematic cross sectional view of a power section of a progressive cavity motor.

Figure 1A is a schematic cross sectional view of the power section shown in Figure 1.

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Figure 2 is a schematic cross sectional view of a coiled tubing inserted into the wellbore.

Figure 3 is a schematic cross sectional view of an anchor inserted downhole in the
10 wellbore.

Figure 4 is a schematic cross sectional view of other components coupled to a tubing member.

15 Figure 5 is a schematic cross sectional view of a whipstock set in position and an end mill cutting an exit through the casing.

Figure 6 is a schematic cross sectional view of an arrangement of components using a hydraulic anchor 38.

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Figure 7 is a schematic cross sectional view of the arrangement shown in Figure 6 including a whipstock set in position and an end mill cutting an exit through the casing.

Figure 8 is a schematic cross sectional view of a downhole motor.

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Figure 9 is a schematic cross sectional view of an alternative embodiment of the downhole motor shown in Figure 8.

30 Figure 2 is a schematic cross sectional view of a tubing member inserted into the wellbore. The well is drilled through a surface 11 to establish a wellbore 10. Typically, the wellbore is cased with a casing 14. A space 12 between the drilled wellbore and the casing 14 is sealed with a solidifying aggregate such as concrete. A reel 13 is disposed adjacent the wellbore 10 and contains a quantity of tubing, such as coiled tubing 15. The

coiled tubing 15 typically does not rotate to a significant degree within the wellbore. The reel 13 of coiled tubing provides an amount of tubing that can be relatively rapidly inserted in and removed from the wellbore 10 compared to drill pipe or tubing which must be assembled and reassembled in sections. Various components can be coupled to the coiled tubing 15 as described below beginning at the lower end of the arrangement. An anchor 18, such as a bridge plug, packer, or other setting device, is attached to the tubing generally on a lower end of the arrangement. A whipstock 20 is attached to the anchor 18 and includes an elongated tapered surface that guides the cutter 22, such as an end mill, outwardly toward casing 14. A cutting tool 22 is attached to the whipstock with a connection member 24. A connection member 24 can be a piece of metal that is later sheared downhole as the cutting tool is actuated. A spacer mill 26 can then be coupled to the cutting tool 22. The spacer mill 26 typically is a mill used to further define the hole or exit created by the cutting tool 22. In other embodiments, other types of cutters can be coupled, such as hybrid bits that are capable of 'milling an exit and continuing to drill into the formation. An exemplary hybrid bit is disclosed in U.S. Patent Serial No. 5,887,668 and is incorporated by reference herein. In some arrangements, a stabilizer sub 28 is attached to the coiled tubing 15. The stabilizer sub 28 has extensions protruding from the exterior surface to assist in concentrically retaining the tubing member and components in the wellbore 10. A motor 30 can be attached to the arrangement of components above the cutters. The motor 30 is used to rotate the cutters while the coiled tubing remains relatively rotationally stable. Preferably, the motor 30 allows a quantity of fluid to flow through the motor without rotation of the motor at a first time and then allows a second quantity and/or pressure of fluid to flow through the motor at a second time to rotate the cutters. A position measuring member 32, such as an MWD tool, is coupled above the motor 30. The position measuring member 32 requires a certain level of flow typically, 80-100 gallons per minute (6-8 litres per second) to actuate and provide feedback to equipment located at the surface 11. An orienter 34 is coupled to the coiled tubing 15 above the position measuring member 32. The orienter 34 is a device that enables incremental angular rotation of the components to orient the whipstock in a certain direction. An exemplary orienter is available from Weatherford International. Generally, the orienter 34 is actuated by starting circulation and stopping circulation of fluid flowing down the coiled tubing 15. Each pulse of fluid indexes the orienter, generally, about 15-30°.

depending upon the tool. Thus, the orienter 34 can rotate the arrangement containing the whipstock to a desired orientation within the wellbore, while the position measuring member 32 provides feedback to determine the orientation. Heretofore, utilising an MWD tool with a motor on a coiled tubing while orienting the whipstock has not been 5 available. The flow required to actuate the orienter 34 and position measuring member 32 would typically turn the motor 30 and change the orientation of whipstock 20. Thus, the accuracy of the alignment between the orienter and the whipstock would be changed and become unknown downhole.

10 It is to be understood that the arrangement in Figure 2 is merely exemplary and, therefore, many arrangements are possible. For example, the anchor 18 may be separately coupled to the coiled tubing 15 and set in position in one trip. The other components such as 0 the whipstock, mill, motor, orienter and position measuring member may then be inserted downhole in a second trip. In other embodiments, the 15 anchor and the whipstock may be inserted in a first trip and the other components inserted in a second trip.

The motor 30 allows flow without substantial rotation at a first flow rate and/or pressure to allow sufficient flow through the orienter 34 and the position measuring member 32 20 without actuation of the motor, as described with reference to Figures 8-9. The flow in the tubing member through the orienter, position measuring member and motor is then exhausted through ports in the end mill and flows outwardly and then upwardly through the wellbore 10 back to the surface 11. Flow through or around the motor 30 allows the reduction of at least one trip in setting the anchor 18 and starting to drill the exit in the 25 wellbore 10.

Figures 3-5 are cross sectional views of a wellbore, showing a exemplary sequence in 30 setting a mechanical anchor, orienting the whipstock, and beginning to cut an exit in two trips. Various components including an anchor 18, a whipstock 20, a cutting tool 22, a motor 30, a position measuring member 32 and an orienter 34 are coupled to the tubing member 16, such as coiled tubing.

Figure 3 is a schematic cross sectional view of an anchor inserted downhole in the wellbore. A tubing member 16, such as coiled tubing, is inserted downhole through the wellbore 10 and inside the casing 14. An anchor 18, such as a mechanical anchor, is coupled to the lower end of the tubing member. The mechanical anchor 18 requires mechanical actuation to set the anchor in position, as known to those with ordinary skill in the art. After the anchor 18 is set, the anchor is released from the tubing member and the tubing member is retrieved back to the surface.

Figure 4 is a schematic cross sectional view of various components coupled to the tubing member 16 after the anchor 18 is set. At a lower end of the arrangement, a whipstock 20 is attached to a cutting tool 22 through a connection member 24. A spacer mill 26 is coupled to the cutting tool 22. A stabilizer sub 28 is coupled to the spacer mill 26 and a motor 30 is coupled to the stabilizer sub. A position measuring member 32 is coupled to the motor 30 and an orienter 34 is coupled to the position measuring member. The orienter is also coupled to the tubing member 16. The term "coupled" as used herein includes at least two components directly coupled together or indirectly coupled together with intervening components coupled therebetween.

The tubing member 16 and the components coupled thereto are lowered downhole, so that the whipstock 20 is adjacent the anchor 18. Fluid flow through the tubing member 16 is used to actuate the orienter 34 and rotationally index the components below the orienter to a desired orientation. The position measuring member 32 provides feedback to the equipment located generally on the surface 11 (shown in Figure 2) to determine the position of the whipstock 20 to an operator. The motor 30 allows sufficient flow through the orienter 34 and the position measuring member 32 to allow actuation thereof without rotating the motor 30 and the components attached therebelow. Thus, a relative alignment between the position measuring member, orienter, motor, mills, and whipstock is maintained. Once the whipstock is properly oriented, the tubing member 16 is further lowered, so that the whipstock 20 engages the anchor 18 and is set in position.

Figure 5 is a schematic cross sectional of the whipstock 20 set in position and the cutting tool 22 cutting an exit through the casing 14 at an angle to the wellbore 10. As

the flow rate and/or pressure of fluid within the tubing member 16 increases, the motor 30 is actuated and turns the cutting tool 22. Sufficient torque created by the motor 30 shears the connection member 24 between the whipstock 20 and the cutting tool 22. The cutting tool 22 begins to turn and is guided at an angle to the wellbore 10 by the whipstock 20. As the tubing member 16 is further lowered downhole, the cutting tool 22 cuts at an angle through the casing 10 and creates an angled exit therethrough. In some embodiments, the casing 14 may not be placed in a wellbore 10. It is to be understood that the arrangements described herein for cutting an angled exit apply regardless of whether the casing 14 is placed in the wellbore.

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The orienter 34 is designed to be rotationally stable during the operation of the motor 30 because the pressure is not pulsed from a low to high pressure that otherwise actuates the orienter. However, if the orienter 34 is actuated and does index, the change of the orienter does not effect the ability of the motor 30 to operate the cutting tool 22 nor the direction of the end mill because the end mill is guided by the whipstock 20.

Figure 6 is a schematic cross sectional view of an arrangement of components using a hydraulic anchor 38. Figure 6 shows the arrangement being inserted downhole in the wellbore and includes a hydraulic actuator 35 coupled to a corresponding set of components described in reference to Figures 2-5. The components include, for example, an anchor 20 and a cutting tool 22 coupled to the anchor 20 with a connection member 24. Further, the arrangement includes a spacer mill 26, a stabilizer sub 28, a motor 30, a position measuring member 32 and an orienter 34 coupled to a tubing member 16. A hydraulic anchor 38 can be actuated remotely and thus does not require a separate trip, as described in reference to Figure 3. Therefore, the arrangement shown in Figure 6 can be used to set the anchor and the whipstock and begin cutting an exit in wellbore in a single trip. The arrangement is lowered downhole to an appropriate position. The whipstock 20 is oriented using the orienter 34 to a position determined by the position measuring member 32, while the motor 30 allows flow therethrough without substantial rotation of the motor. The hydraulic anchor 38 is set with a hydraulic fluid flowing through a tube (not shown).

Figure 7 is a schematic cross sectional view of the arrangement shown in Figure 6. The hydraulic anchor 38 and whipstock 20 have been oriented and set in position. The motor 30 is actuated by increased flow rate and/or pressure and turns the cutting tool 22 and other members located below the motor 30. As the cutting tool 22 rotates and the tubing member 16 is lowered downhole, the cutting tool 22 is guided by the whipstock 20 and cuts an exit 36 through the wellbore 10. Thus, setting the anchor, orienting the whipstock, and cutting an exit can be performed in a single trip.

One example of a downhole motor that can be used as described herein is a modified progressive cavity motor. Figure 8 is a schematic cross sectional view of such a motor. The progressive cavity motor 48 includes a top sub 50 having a fluid inlet 52, an output shaft 54 having a fluid outlet 56, and a power section 58 disposed therebetween. The power section includes a stator 60 circumferentially disposed about a rotor 62. The rotor 62 has a hollow cavity 64 disposed therethrough that is fluidically coupled from the inlet 52 to the outlet 56. An inlet 66 of the power section portion of the motor 48 allows fluid to flow into a progressive cavity created between the stator 60 and the rotor 62 as the rotor rotates about the stator and to exit an outlet 68 of the power section, as described in reference to Figures 1 and 1A.

An annulus 70 downstream of the outlet 68 is created between the inner wall of the motor 48 and various components disposed therein, which provide a flow path for the fluid exiting the outlet 68. A transfer port 72 is fluidically coupled from the annulus 70 to a hole 74 disposed in the output shaft 54 and then to the output 56. A restrictive port 75 can be formed between the hollow cavity 64 and the annulus 70 to fluidically couple the hollow cavity 64 to the annulus 70.

Because the rotor precesses within the stator, an articulating shaft 76 can be disposed between the rotor 62 and the output shaft 54, so that the output shaft 54 can rotate circumferentially within the motor 48. The articulating shaft 76 can include one or more knuckle joints 78 that allow the stator to precess within the stator with the necessary degrees of freedom. A bearing 80 can be disposed on an upper end of an output shaft 54 and a lower bearing assembly 82 can be disposed on a lower end of an output shaft 54.

One or more seals, such as seals 84, 86, assist in sealing fluid from leaking through various joints in the downhole motor 48.

In operation, fluid is flowed down the tubular member 16, shown in Figures 3-7 and 5 enters inlet 52 of the top sub 50. At a relatively low flow rate, such as 10 gallons per minute (0.8 litres per second), the flow rate and pressure are insufficient to rotate the rotor 62 within the stator 60 and the fluid stops at inlet 66. However, some fluid flows into the hollow cavity 64 in the rotor 62 and through port 75, into the annulus 70, and eventually through the output 56 of the output shaft 54. Thus, the fluid from the top of 10 the motor is able to flow through the motor without substantially actuating the motor. The flow through the hollow cavity 64 allows various tools located upstream and downstream from the motor to receive flow for indexing, orientation or other functions, as has been described herein.

15 The flow rate and/or pressure can be increased to a level at which the rotor 62 rotates within the stator 60 and creates torque on the output shaft 54, so that the motor can rotate downstream tools, such as a cutting tool, as has been described herein. The flow through the hollow cavity 64 reaches a maximum rate for a given pressure. The flow through the inlet 66 and outlet 68 at greater flow rates and pressures overcome flow 20 through the hollow cavity 64. Further, the motor can be activated and deactivated by adjusting the flows without having to retrieve and reset the motor.

Figure 9 is a schematic cross sectional view of another embodiment of the downhole motor 48. Similar elements in Figure 8 are similarly numbered in Figure 9. A top sub 50 having an inlet 52 is coupled to a power section 58 having a stator 60 and rotor 62 that is disposed therein. Power section 58 is coupled to an output shaft 54 having an outlet 56. A flow path exist between the inlet 52 and an inlet 66 between the stator 60 and the rotor 62, an outlet 62, an annulus 70, a transfer port 72, and a hole 74 that is coupled to the outlet 56.

30 Generally, fluid is flowed through the inlet 52 at a flow rate and pressure that will force the rotor 62 to rotate within the stator 60. It is known that a percentage of the fluid, at a given pressure and flow rate, can leak through the cavities formed between the stator 60

and the rotor 62, but typically the rotor 62 begins to rotate before a substantial amount of fluid leaks therethrough. In the embodiment shown in Figure 9, the rotation of the rotor is restrained by a shear pin 88. The shear pin 88 can be disposed in a hole 90 formed through an outer shell 92 of the motor 48 and into the output shaft 54. The shear pin can be located at other positions along the motor 48 and the position shown in Figure 9 is merely exemplary. The shear pin restrains the output shaft from rotation and allows an increased flow between the progressive cavity formed between the stator 60 and the rotor 62 without the rotor substantially rotating. Thus, fluid can be flowed through the downhole motor 48 for activation of tools both upstream and downstream of the motor without the motor substantially rotating. The fluid flow rate and/or pressure can be increased to a level at which the torque created on the rotor 62 shears the shear pin 88 and allows the rotor to rotate the output shaft 54.

While the foregoing is directed to various embodiments of the present invention, other and further embodiments may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow. For example, "up", "clown" and variations thereof include not only a typical orientation of a vertical shaft for wellbore, but also includes a lateral shaft formed by directional drilling, such that "up" would be directed toward the beginning of the wellbore and "down" would be directed toward the lateral end of the wellbore. Furthermore, any flow rates described herein are exemplary and could vary depending on the well conditions, fluids used, size of tools and so forth. Further, variations in the progressive cavity motor can be made as well as the use of other types of motors that would allow fluid to flow through the motor, so that tools coupled upstream and downstream of the motor can be activated without the motor substantially rotating.

CLAIMS:

1. A method of cutting a hole at an angle to a wellbore, comprising:
 - a) coupling a position measuring tool, a downhole motor, a cutting tool, a whipstock and an anchor to a tubular member;
 - b) orienting the whipstock to a desired orientation; and
 - c) actuating the anchor.
2. A method as claimed in claim 1, wherein actuating the anchor occurs without substantially changing the orientation of the whipstock.
3. A method as claimed in claim 1 or 2, further comprising measuring the orientation of the whipstock *in-situ* prior to actuating the anchor.
4. A method as claimed in claim 1, 2 or 3, wherein the tubular member is a coiled tubing.
5. A method as claimed in any preceding claim, further comprising lowering the position measuring tool, downhole motor, cutting tool, whipstock and anchor into the wellbore and wherein lowering into the wellbore, orienting the whipstock, and actuating the anchor occurs in a single trip.
6. A method as claimed in any preceding claim, wherein orienting the whipstock comprises using an orienter to orient the whipstock.
7. A method as claimed in any preceding claim, wherein the position measuring tool is arranged between the orienter and the motor.
8. A method as claimed in claim 1, further comprising lowering the anchor into the wellbore and actuating the anchor in position prior to lowering the position measuring tool, downhole motor, cutting tool and whipstock into the wellbore and orienting the whipstock.

9. A method as claimed in any preceding claim, further comprising selectively maintaining the motor in a stationary rotational position relative to the whipstock while flowing a fluid through the motor and while at least partially orienting the whipstock.

5 10. A method as claimed in claim 9, further comprising flowing fluid through a hollow motor shaft of the motor.

11. A method as claimed in claim 10, wherein flowing the fluid through the hollow motor shaft comprises flowing at a first flow rate while orienting the whipstock and 10 flowing at a second flow rate while actuating the motor to rotate the cutting tool.

12. A method as claimed in claim 9, wherein selectively maintaining the motor in a stationary rotational position comprises locking a motor shaft of the motor in rotational position while flowing the fluid through the motor and while orienting the whipstock.

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13. A method as claimed in claim 12, further comprising creating sufficient torque on the motor shaft to unlock the motor shaft and rotate the cutting tool.

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14. A method as claimed in claim 13, further comprising increasing a pressure of the fluid to unlock the motor shaft.

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15. A system for cutting a hole at an angle to a wellbore, comprising:
a) a tubular member; and
b) a plurality of components having a position measuring tool, a downhole motor, a cutting tool, a whipstock and an anchor coupled to the tubular member.

16. A system as claimed in claim 15, wherein the components further comprise an orienter coupled to the tubular member.

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17. A system as claimed in claim 16, wherein the tubular member is a coiled tubing.

18. A system as claimed in claim 16 or 17, wherein the components are arranged in an order of an orienter, a motor, a cutting tool and a whipstock.

19. A system as claimed in claim 18, wherein the position measuring tool is arranged between the orienter and the motor.

5 20. A system as claimed in any of claims 15 to 19, wherein the motor comprises a motor shaft that is rotationally stationary relative to the whipstock while a fluid flows through the motor.

10 21. A system as claimed in claim 20, wherein the motor shaft comprises a hollow motor shaft.

15 22. A system as claimed in claim 21, wherein the hollow motor shaft is sized to allow the fluid to flow through the shaft at a first flow rate while maintaining the rotationally stationary position and to allow the fluid to rotate the motor shaft at a second flow rate.

23. A system as claimed in claim 20, wherein the stationary motor shaft comprises a locked motor shaft while fluid flows through the motor at a first pressure and the whipstock is at least partially oriented.

20 24. A system as claimed in claim 23, further comprising a shear member to lock the motor shaft.

25 25. A system as claimed in claim 24, wherein the shear member is sized to shear and unlock the motor shaft when the pressure of the fluid is increased to a second pressure.

26. An apparatus for use in a wellbore, comprising:
a) a motor body;
b) a motor shaft disposed at least partly internal to the motor body; and
30 c) a fluid channel in communication with the motor shaft,
the motor shaft being selectively non-rotational relative to the motor body while fluid flows through the motor at a first fluid flow rate and rotational while the fluid flows at a second fluid flow rate.

27. An apparatus as claimed in claim 26, wherein the motor shaft comprises a channel formed at least partially through the motor shaft, the channel being fluidically coupled to an inlet and an outlet of the motor.

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28. An apparatus as claimed in claim 26, further comprising a shear member disposed between the motor shaft and the motor body.

29. A method of cutting a hole at an angle to a wellbore, comprising:

10 a) coupling an anchor to a coiled tubing;
 b) actuating the anchor in the wellbore;
 c) coupling a position measuring tool, a downhole motor and a cutting tool to a coiled tubing;
 d) orienting the whipstock to a desired orientation; and
15 e) actuating the motor to turn the cutting tool.

30. A method as claimed in claim 29, wherein orienting the whipstock comprises using an orienter to orient the whipstock.

20 31. A method as claimed in claim 29 or 30, further comprising selectively maintaining the motor in a stationary rotational position relative to the whipstock while flowing a fluid through the motor and while at least partially orienting the whipstock.

25 32. A method as claimed in claim 29, 30 or 31, further comprising flowing fluid through a hollow motor shaft of the motor at a first flow rate while orienting the whipstock and flowing at a second flow rate while actuating the motor to rotate the cutting tool.

30 33. A method as claimed in claim 29, 30 or 31, further comprising locking a motor shaft of the motor in rotational position while flowing the fluid through the motor and while orienting the whipstock.

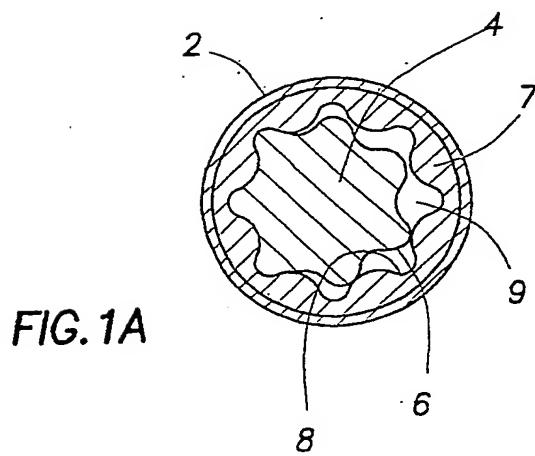
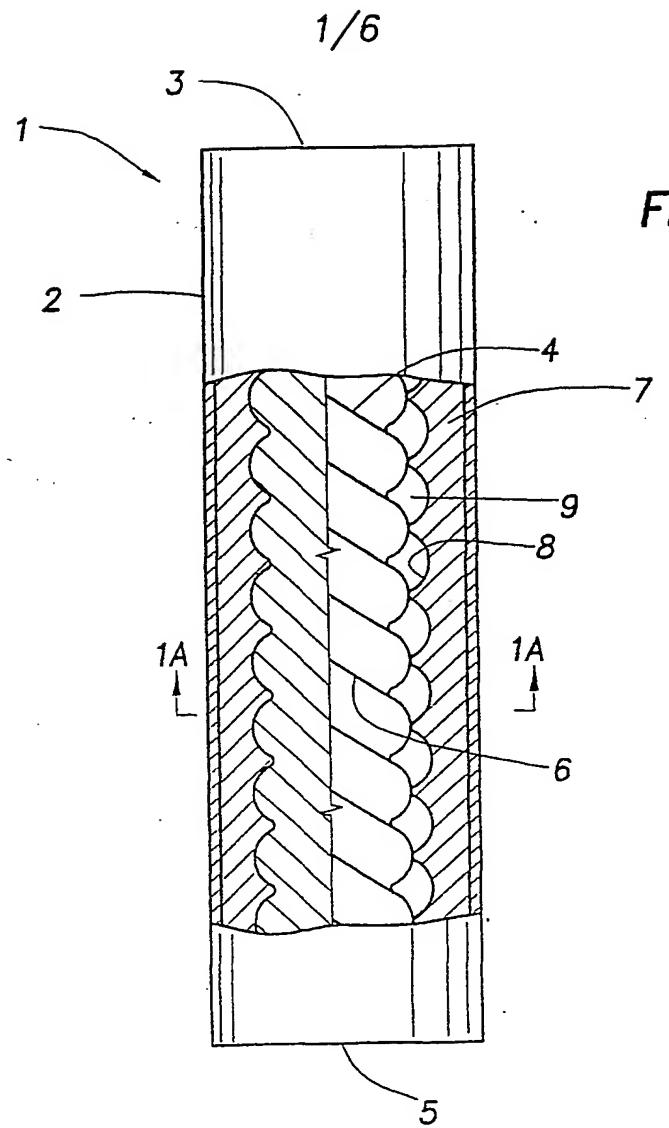
34. A method as claimed in claim 33, further comprising creating sufficient torque on the motor shaft to unlock the motor shaft and rotate the cutting tool.

35. A system for cutting a hole at an angle to a wellbore, comprising:

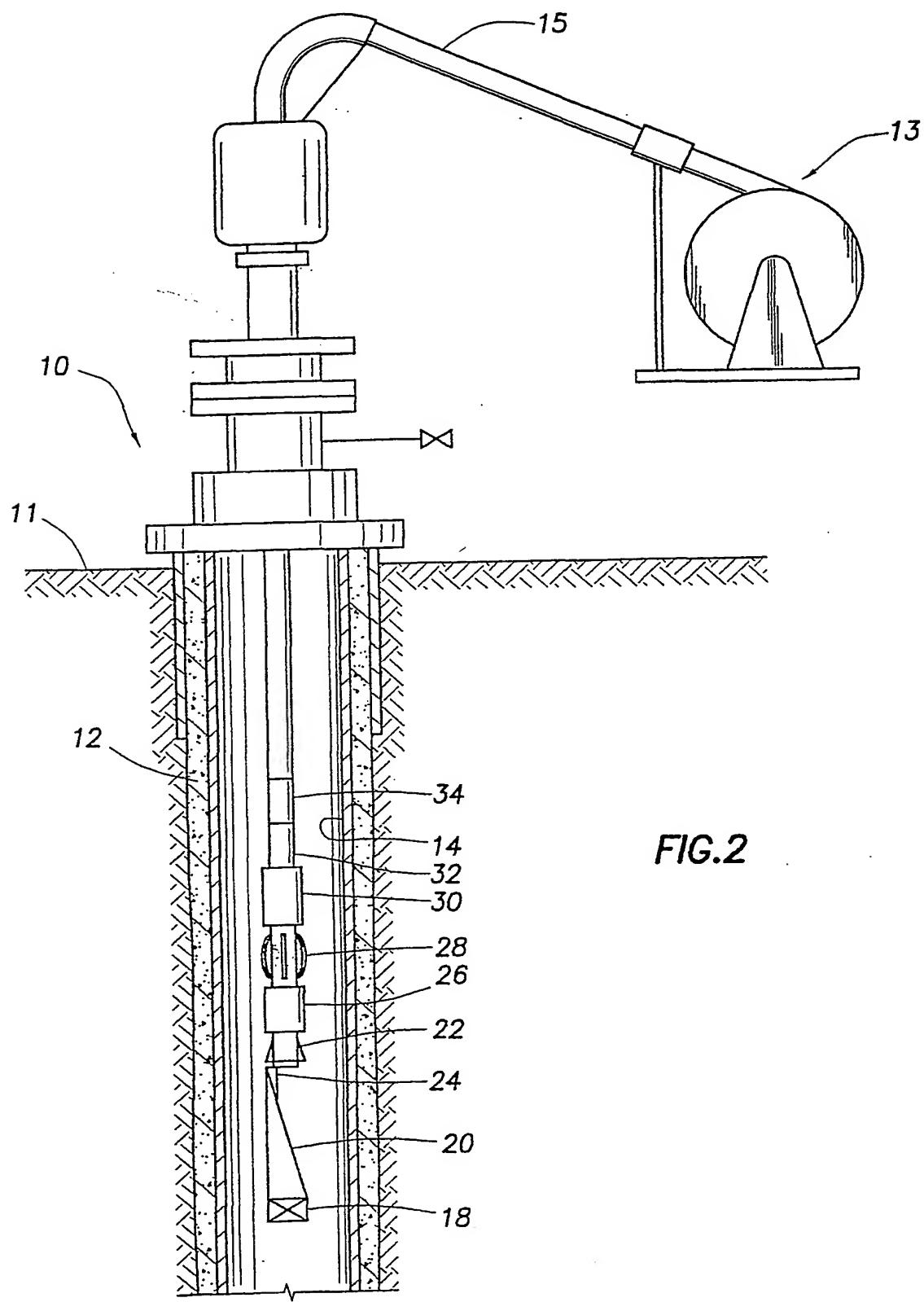
- 5 a) a coiled tubing;
- b) an anchor coupled to the coiled tubing at a first time; and
- c) a position measuring tool, a downhole motor, a cutting tool and a whipstock coupled to the coiled tubing at a second time.

10 36. A system as claimed in claim 35, wherein the motor comprises a motor shaft having a channel formed at least partially therein, the channel being fluidically coupled to an inlet and an outlet of the motor.

15 37. An apparatus as claimed in claim 35, wherein the motor comprises a motor body and a motor shaft and further comprising a shear member disposed between the motor shaft and the motor body.



2/6



3/6

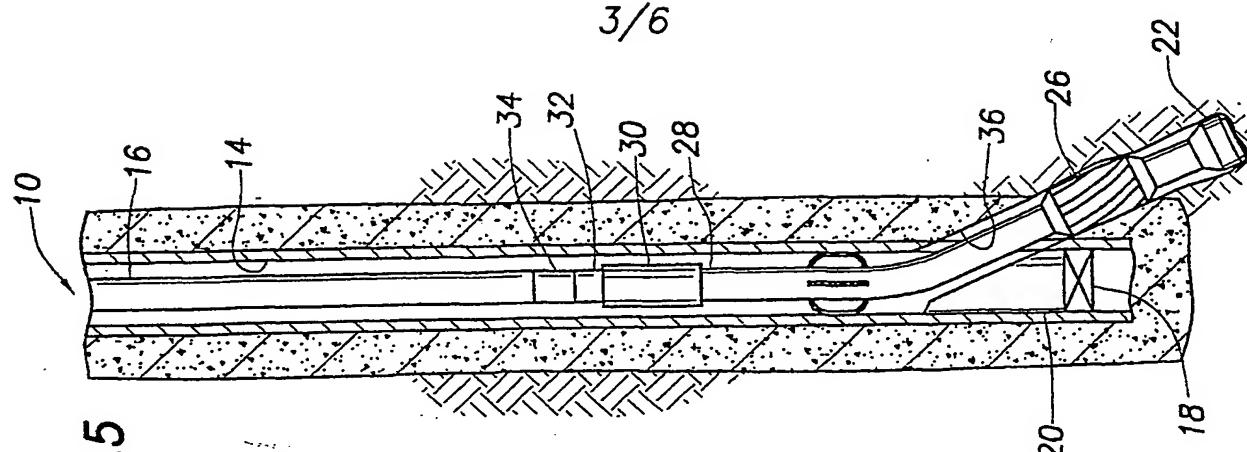


FIG. 5

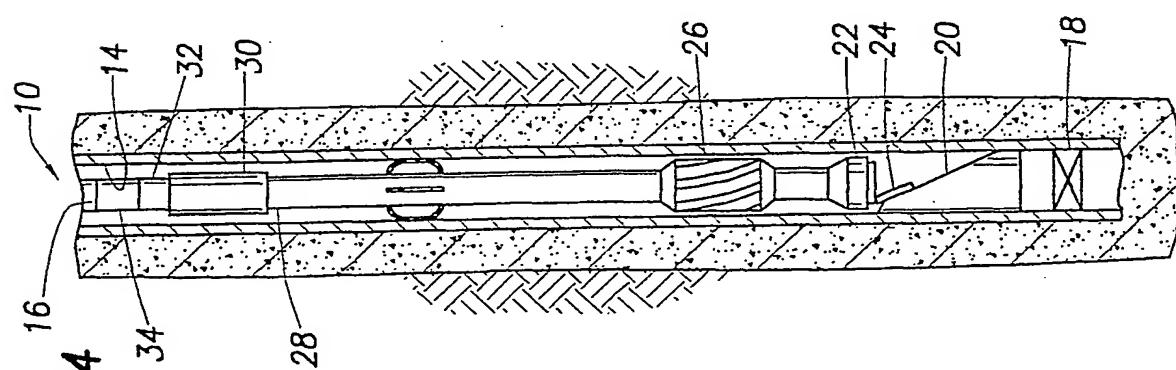


FIG. 4

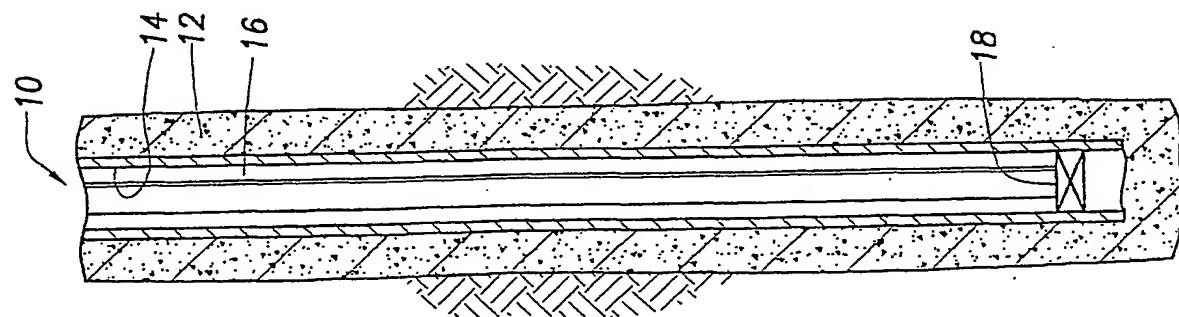


FIG. 3

4/6

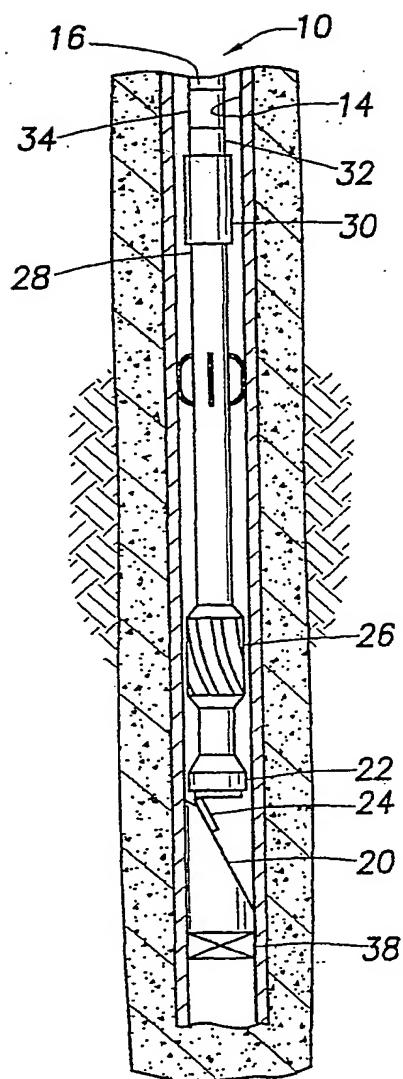


FIG.6

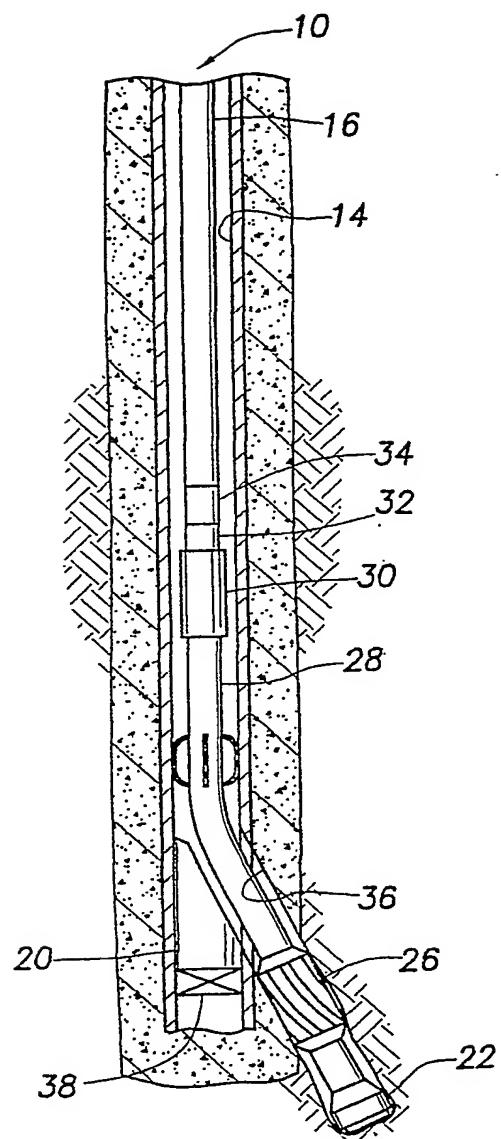


FIG.7

FIG.8

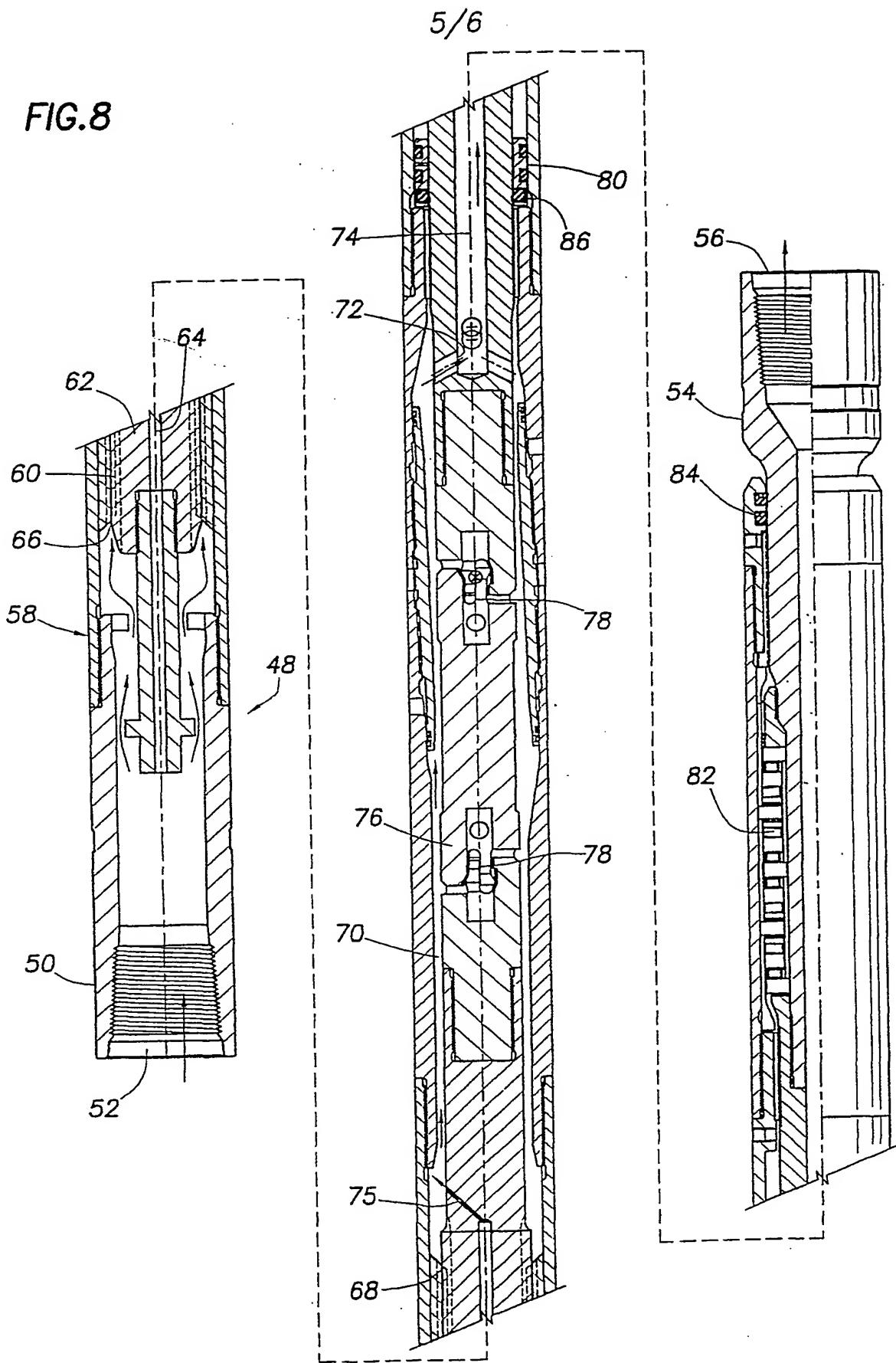
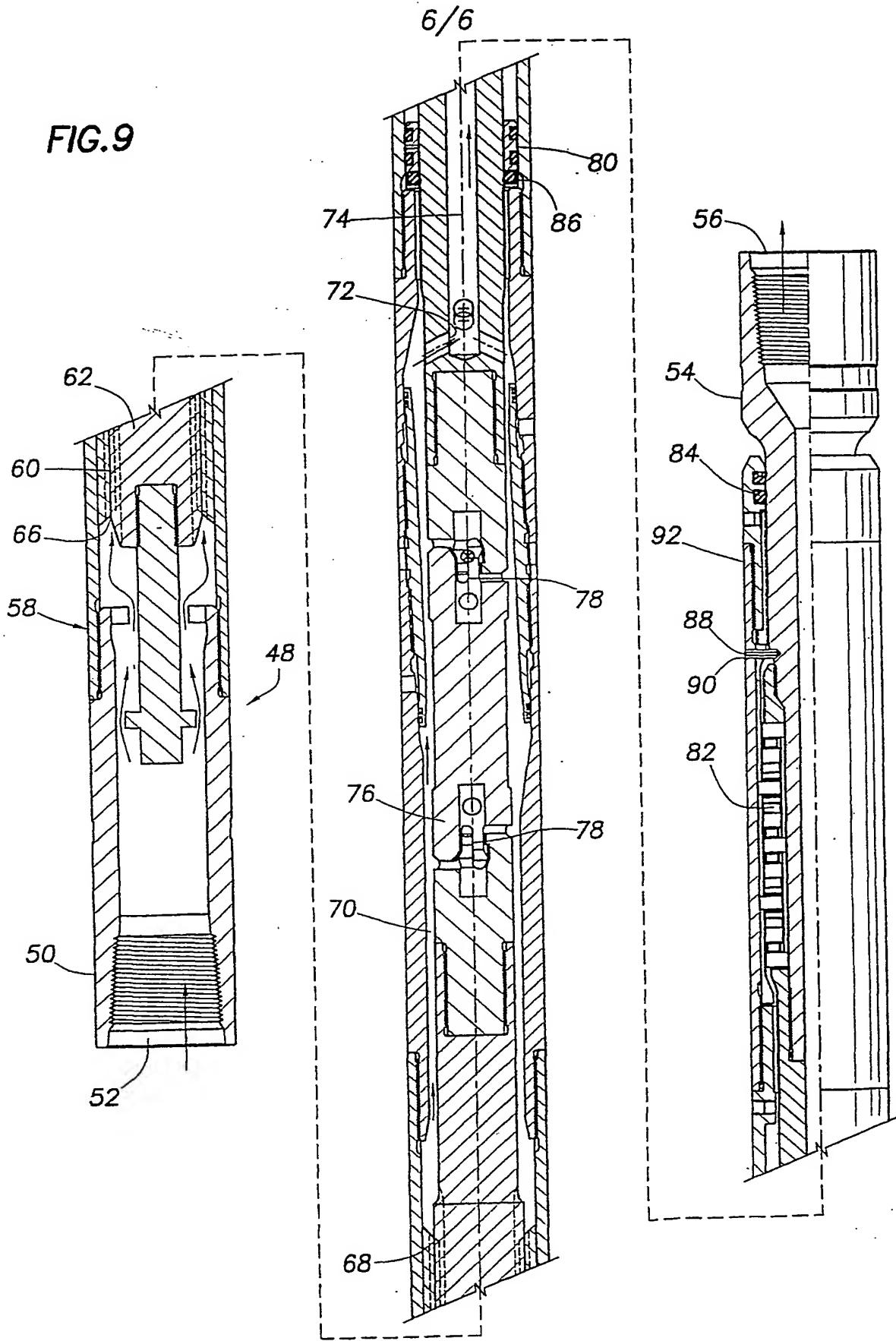


FIG.9



INTERNATIONAL SEARCH REPORT

Inte
nal Application No
PCT/GB 01/02791

Patent document cited in search report	Publication date		Patent family member(s)	Publication date
EP 0774563	A 21-05-1997	US CA EP NO US	5738178 A 2189834 A1 0774563 A2 964875 A 6129160 A	14-04-1998 18-05-1997 21-05-1997 20-05-1997 10-10-2000
GB 2326898	A 06-01-1999	AU CA NO US	7397998 A 2242026 A1 983070 A 6109347 A	14-01-1999 03-01-1999 04-01-1999 29-08-2000
US 5443129	A 22-08-1995	GB NO	2291448 A ,B 952003 A	24-01-1996 23-01-1996
US 5154231	A 13-10-1992	CA DE FR GB JP NO	2051724 A1 4129346 A1 2666844 A1 2248079 A ,B 4231591 A 913676 A	20-03-1992 26-03-1992 20-03-1992 25-03-1992 20-08-1992 20-03-1992

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 01/02791

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E21B7/06 E21B4/02 E21B23/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 774 563 A (BAKER HUGHES INC) 21 May 1997 (1997-05-21) column 5, line 22 - line 32 ---	1-37
A	GB 2 326 898 A (BAKER HUGHES INC) 6 January 1999 (1999-01-06) abstract ---	1-37
A	US 5 443 129 A (BAILEY THOMAS F ET AL) 22 August 1995 (1995-08-22) cited in the application column 10, line 21 -column 11, line 50 ---	1-37
A	US 5 154 231 A (BAILEY THOMAS F ET AL) 13 October 1992 (1992-10-13) cited in the application column 3, line 52 - line 68 ---	1-37

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Patent family members are listed in annex.

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Date of the actual completion of the international search

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl
Fax: (+31-70) 340-3016

Authorized officer

Garrido Garcia, M